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ABSTRACT

This packet includes three pamphlets which together provide information and suggestions intended to aid counselors and teachers in encouraging young women to consider careers in science and engineering. Pamphlet One, "What Can Counselors and Teachers Do to Encourage Young Women," offers suggestions based upon others' experiences that can aid in developing a more supportive environment for women students. Pamphlet Two, "An Overview of Science and Engineering Careers and Sources of Information About Careers and the Education and Employment of Women," provides brief descriptions of the range of career choices in the engineering and physical sciences. Pamphlet Three, "Especially for Women Students: Facts, Fiction, and Fun Reading About Science and Technology," presents a bibliography regarding aspects of career prospects and selecting a course of study. (Author/CS)

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What Can Counselors and Teachers do to Encourage Young Women?

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DESCRIPTION OF THE PACKET

INTRODUCTION

Why Involve Educators?
Why Encourage Women?

WHAT CAN COUNSELORS AND TEACHERS DO?

Create a Supportive School Climate

Integrate Career Information into Courses and Special Events

Establish Linkages with Employers and other Community Organizations for Person-to-Person Contacts

Help Women Plan for College

Find Out about the Participation of Women Students in Mathematics, Physics, and Chemistry in Your School

Plan In-Service Programs

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE 035 359

DESCRIPTION OF THE PACKET

The packet includes three pamphlets that together provide information and suggestions intended to make it easier for counselors and teachers to encourage young women to consider science and engineering careers. A special flyer for students is also included to answer some important questions young women ask.

Pamphlet 1. What Can Counselors and Teachers do to Encourage Young Women Counselors and teachers play significant roles in young women's lives. Here are suggestions based upon others' experiences that can aid in developing a more supportive environment for women students.

Pamphlet 2. This has two parts. 1) An Overview of Science and Engineering Careers 2) Sources of Information about Careers and The Education and Employment of Women. This pamphlet provides brief descriptions of the range of career choices in engineering and the physical sciences, with special attention to the computer revolution. Although the life sciences are not included in this presentation,

they also require basic preparation in the physical sciences and mathematics. The second part includes useful references for those seeking authoritative and inexpensive information.

Pamphlet 3. Especially for Women Students: Facts, Fiction, and Fun Reading about Science and Technology Here is an exciting bibliography that counselors and teachers can present to women students -- even those who may not think they are particularly interested in science.

The emphasis in this packet is on career prospects, but preparing for future employment should surely not be the only reason for selecting a course of study. For one thing, the future demand for particular kinds of workers is unpredictable. But, even more significant, as no one knows better than counselors or teachers, instilling a love of learning is the best foundation for evolving a satisfactory life plan.

This project was initiated by members of The Committee on the Status of Women in Physics of the American Physical Society because of their desire that young women discover the excitement and

opportunities in the fields of physical science and engineering. Edith Ruina prepared the packet, drawing upon several years of experience as Director of WITS (Work in Technology and Science) at the Massachusetts Institute of Technology.

Since we are concerned about the age group that is in transition from childhood to adulthood, we resolved the delicate terminology problem by sometimes referring to "girls" and sometimes to "young women."

Edith Ruina
Cambridge, Mass.
April 1981

INTRODUCTION

Why Involve Educators?

Are you teachers and counselors being asked to assume yet another of society's challenges? Yes! But there are rewards for you and for your students. By encouraging girls and young women to explore career possibilities in mathematics and science, you will be contributing in new ways to the development of human resources for a productive society. The social impact of science and technology is so great that it should not be the exclusive domain of engineers and scientists, nor of males. In undertaking this task you are not expected to know everything in advance about careers -- you can share the exploring with your students. Your participation can have great impact on young women's future aspirations and career choices, and at the same time can broaden your own horizons.

As educators, you will seek effective new ways to link education and employment. This packet includes a number of suggestions that have worked in other programs to get parents, employers, and people

in other community organizations to aid schools in providing career orientation. There's no denying that this takes time and effort, but it can pay off in building greater community involvement in schools. And it is fun! Most counselors and teachers who may have had little direct contact with engineers and scientists enjoy meeting them and visiting their work sites.

You can increase technological and scientific literacy in your school. The primary objective of this packet is to motivate women; however, development of a reasonable understanding of physical science and technology should be a part of a well-rounded education for all students.

Why Encourage Women?

As described in Pamphlet 2, some computer-related occupations and branches of engineering will probably require more personnel than are preparing for these fields. The consequence of women's lack of preparation for science and engineering careers is that they must seek employment in many fields where openings and salaries are less favorable. In

1978, women accounted for about 1.6% of all engineers, approximately 22,000 women. Most women engineers were employed in business and government. More than half of the women engineers entered the labor market less than five years ago.

Industries employing scientists and engineers actively seek qualified women and, in some instances, women's entry salaries are even slightly higher than men's. This is not intended to be a "hard sell," but rather to suggest that if young women understood the excitement and the variety of careers in engineering and science, many more of them would anticipate career satisfaction in these areas. Certainly women should be free to choose according to their preferences, limited only by real possibilities, but until recently, even their vision of possibilities has been restricted by stereotyped notions of women and of careers. Much can be done by educators and parents to shatter these stereotypes, but this requires communicating information to students about the world of work in captivating ways.

The fact that few women are in careers in science and technology underscores the need for alerting young women to future prospects while they can still choose the high-school courses that give them appropriate preparation.

Few girls take elective courses in advanced mathematics, chemistry, and physics in high school. Even the girls who take advanced mathematics and do well are much less likely than their male classmates to consider engineering and physical science majors in college.

The 1979 College Board Report of a survey of over 900,000 college-bound seniors illustrates the continuing differences between male and female intentions regarding areas of study.

	Male	Female
Physical Sciences & Related Areas	27.8	7.2
- Computer Science/Systems Analysis	4.0	2.7
- Engineering*	18.9	2.3
- Mathematics	1.4	1.1
- Physical Sciences	3.5	1.1
Biological Sciences & Related Areas	17.7%	26%
- Agriculture	2.4	1.2
- Biological Sciences	3.9	3.6
- Forestry/Conservation	1.8	0.6
- Health & Medical*	9.7	20.7

The largest male and female differences are in the health and medical areas and in engineering. The health and medical choices largely reflect female preferences for nursing and medical or dental technology, traditional women's fields, though an increasing number of women plan to become physicians. Engineering continues to show the greatest differences between males and females despite the favorable job outlook.

Because of their preferences for traditional women's fields, women are a small proportion of the college majors in the physical sciences and engineering. An example is engineering where the total number of women is still relatively small. However, the percentage increase in the past few years is dramatic.

Women Engineering Graduates*

1965-1980

Year Ending in June	Bachelor's	Percentage of Total Eng. B.S.
1965	139	0.38
1970	358	0.83
1975	878	2.30
1976	1,376	3.62
1977	1,961	4.89
1978	3,280	7.11
1979	4,716	9.00
1980	5,680	9.70

*Source: U. S. Office of Education annual statistics 1952-1966. Engineering Manpower Commission surveys 1967-1980.

We see this enrollment change as demonstrating that women are beginning to recognize that they can be successful in such fields, but continued education and encouragement are clearly necessary. This is especially true because the country requires a continuous supply of skilled engineers and scientists to maintain productivity and women represent valuable, inadequately-tapped resources.

WHAT CAN COUNSELORS AND TEACHERS DO?

Create a Supportive School Climate

Young women in their adolescent years are exploring their personal preferences and abilities and how they might incorporate these into their future family, work, and leisure roles. School has a powerful impact upon young women's perceptions of themselves and of their present and future choices. The messages come not only through formal curricula but also through the atmosphere of the school.

Counselors and teachers in their respective counseling and classroom roles and in cooperation with each other can map out paths for exploration.

General issues for counselors

Counselors have the primary responsibility for guidance of young people. As a profession, your mandate is to address the total personal development of students, but you cannot accomplish this alone. To motivate young women, it will be essential to overcome notions that science and engineering are unsuitable fields if women are "people-oriented," or if they are not "brains."

Enlist others in the effort to enlarge young women's participation in mathematics and science classes. School board members, administrators, and teachers should be encouraged to support new directions for young women. As you know, parental influence is a major factor in career choice, but until parents themselves have chances to learn about the promise of technological and scientific careers, they are unlikely to encourage their daughters in such directions. Invite parents to share in career program planning and career information activities. Suggest to the principal of your school that faculty members and parents form committees to act upon some of the suggestions in this packet.

Counselors can provide specific information for teachers, most of whom are unlikely to have had occasion to use the Occupational Outlook Handbook or the new junior publication, Exploring Careers. Supplying teachers with excerpts from these excellent U. S. Bureau of Labor Statistics publications is an inexpensive way to provide current information for teachers to share with their students.

In individual and group counseling, young women should be encouraged to elect advanced mathematics and science classes and to talk to counselors when they have difficulties with these courses. With counselors' guidance, groups of women students could form to share their experiences with each other and with faculty members.

Some traditional counseling practices may have to be modified so that they do not inhibit young women's career exploration. One of the effects of the women's movement has been that it has caused all professions to reflect upon subtle ways in which their practices may limit women's horizons.

Occupational classification schemes are convenient to use. However, the division of occupational clusters may discourage students from looking for the similarities in preparation for jobs in different clusters. For example, young women studying chemistry might consider health careers as nurses or laboratory technicians without realizing that they should also think about careers as chemists or engineers. The classification of occupations according to the degree of interaction with data or people or things obscures the many science and engineering careers that incorporate all three. Young women may not realize that engineers and scientists often work in teams, manage, sell, and teach, all people-oriented activities. Because of limited experience in building or laboratory work that requires the use of tools and mechanical or electrical equipment, most girls do not realize the possible satisfaction they could derive from "hands-on" projects and eventually from technical or scientific work. Employers seek well-rounded people who have technical competence and communications skills.

The connotation of "helping professions" is restricted to nursing, teaching, and social work, traditional women's fields where direct personal help is offered. However, women students who want to help humanity should appreciate that dealing with the most important problems of contemporary life often requires engineering and science. Men and women who have humanitarian values and also technical and scientific skills can make invaluable contributions in careers related to research and development in energy, environmental protection, communications, defense and arms control, food supply, and transportation.

In recent years, stress has been placed upon young people developing skills in self-assessment and decision making. Students are asked about the interests and abilities they have already acquired and may inadvertently be discouraged from exploring unknown areas. Young women reviewing their brief life histories may be unaware of personal qualities they could build upon. If women are to expand their possibilities beyond traditional female choices, they must imagine future prospects. Rather than ask

a young woman, "What have you done?" counselors could ask, "What might you become that you have never considered?" Awakened to exploring, she should be encouraged to say, "I never thought about a science or engineering career, but why not?"

A common myth is that only "brains" should study mathematics and science. "Brains" make great contributions, but they need lots of help! Most men are not Einsteins and most women are not Madame Curies; however, women and men who can advance the frontiers of science are essential. The 2,000,000 or so engineers and scientists include people with varying combinations of "brains," imagination and perseverance as well as different amounts of education and experience. The greatest danger is that "protecting" women students from "tough" subjects like mathematics and physical science often results in underselling their abilities. To quote Emily Dickinson, "You never know how nigh you are 'til you are asked to rise."

Counselors can communicate information and encouragement to women students. They can bring into focus for others how the total school

environment impacts upon young women. Then women may be readier to avail themselves of classroom opportunities for mastering mathematics and science.

General issues for teachers

Young women must develop competence in mathematics and science plus confidence that they can succeed in these subjects. Teachers who see students daily in classes are in the most critical roles for developing these qualities. The support and encouragement of mathematics, physics, and chemistry teachers are crucial once high school girls enroll in these courses. Too often, girls report that science teachers "overlook" them or make them the butt of jokes. Science faculty members should take young women seriously, which includes giving them special assignments as laboratory assistants. Many women now in science and engineering are there primarily because a man or woman science teacher assured them they could do it.

Too few students, male or female, pursue elective mathematics and physical science courses despite the urgent requirements for a high level of

scientific and technological literacy among our citizens and in the work force. Although we would like to see total enrollments increase, an immediate goal is to minimize the current disparity between male and female enrollments.

Educators face major challenges in designing imaginative strategies for recruiting; some women have unwarranted fears about the difficulty of mathematics and science. This is reinforced by the fact that most schools offer few alternatives in these subjects just because enrollments are small. This is in contrast to a subject like English where the variety of courses permits greater choice for students with different interests and abilities. Some young women who pursue mathematics and who may even have exceptional mathematics ability may yet shy away from chemistry and physics. The constant educational dilemma -- how to motivate the most gifted and all other students as well -- is particularly acute in the case of mathematics and science.

A safe hypothesis on which to base educational policy and planning is that both men and women can

and must develop mathematical competence. Counselors and teachers are in positions to demonstrate that women succeed in these subjects and to help women reject self-fulfilling prophecies that they cannot. Many more women than the few who now become engineers or scientists have the ability to do so.

A March 1980 National Institute of Education Report by Jane Armstrong, Women in Mathematics, (free -- request from NAEP, Suite 700, 1860 Lincoln St., Denver, CO 80295) summarizes research to date and includes a bibliography. Ms. Armstrong points out that parents, teachers, and counselors can build upon research findings indicating that girls start high school at age thirteen with the same willingness and ability to take mathematics as boys, and that career exploration motivates young women to study mathematics.

Another report that will be useful to mathematics teachers is An Agenda for Action -- Recommendations for School Mathematics of the 1980's, National Council of Teachers of Mathematics,

Inc., 1906 Association Drive, Reston, VA 22011. This can contribute to planning a curriculum that generates excitement, fosters mastery, and makes mathematics seem relevant to young people's lives. Enthusiasm about a subject makes pursuing it more likely.

The ideas presented next have been tested by people who have been experimenting with ways to increase women's participation in engineering and physical science. In most instances, these are down-to-earth suggestions that do not call for major effort or changes, and do not cost a great deal to implement. However, they require planning time which calls for administrative commitment and consent.

Integrate Career Information into Courses and Special Events

Numerous sources of career information exist that may not be labeled as such. The reading list, Especially for Women Students, suggests a rich selection of books that could be purchased for school or public libraries. It was especially

developed to appeal to young women of junior and high school age whether or not they are already interested in science. Mathematics and science teachers could enliven their regular curricula by weekly or biweekly inclusion of readings or personal encounters that communicate applications of mathematics and science. These would not require major diversion of time from the course syllabus and could make students more enthusiastic.

Career information in different forms can become content for many subjects, not only career education courses. For example, in English, students could learn communications and research skills by assignments that call for utilizing government publications about employment and careers. Social studies classes could learn about contemporary society by reading about the computer revolution and other aspects of technological work. Including this kind of knowledge in English and Social Studies courses in the early high school years could complement counselors' and science teachers' efforts.

Science teachers might collaborate with art, mechanical drawing, and shop teachers to develop

some design and building projects that illustrate scientific principles and engage girls in new ways in "hands-on" activities that provide a "feeling" for what technology is all about. Mathematics teachers could give homework assignments that used the charts, graphs, and projections in the Occupational Outlook Handbook to strengthen mathematics comprehension.

After-school and vacation activities can convey the "fun" of engineering and science without fear of grades. Women students and their parents enjoy special progams working with women engineers and scientists in "hands-on" activities. You can obtain some guidelines for conferences by writing to the Math/Science Resource Center, Mills College, Oakland, CA 94613, for a 52-page booklet, Expanding Your Horizons in Science & Mathematics, (Send $3.00.)

Consider organizing after-school clubs such as a JETS (Junior Engineering Technical Society) chapter which promotes interest in engineering, technology, and science. Recognize that special efforts will have to be made to include women. JETS and the Society of Women Engineers can help you plan such

clubs and can advise you of representatives in your area who can suggest projects to demystify science and technology. JETS also publishes a monthly newsletter for schools that provides information about engineering careers. Both JETS and the Society of Women Engineers are located at 345 E. 47th St., New York, N.Y. 10017.

Career fairs can be an effective way to bring together many role models and many students, especially if students are prepared in advance class discussions and reading. A career fair could also be a good public relations event for launching a continuous program for bringing community people into your school. However, a word of caution is in order. High school girls may need encouragement and planning by the schools before they feel comfortable in approaching scientists and engineers, whether at a career fair or at a school event.

Once teachers get "turned on" to presenting information about technology and science, their own imaginations will generate a host of other ways to do this.

Establish Linkages with Employers and Other Community Organizations for Person-to-Person Contacts

No better way exists to prove the relevance of mathematics, physics, and chemistry than to have women engineers and scientists "tell it like it is" to junior and high-school students. These person-to-person experiences develop a good basis for informed decision making by women students. Educators, employers, and students benefit from linking education and employment and discovering common objectives. The following approach has been tested -- and it works!

a) Identify the individuals and organizations in your community who employ, educate, or know about women engineers and scientists.

- Parents who may be engineers or scientists. They can offer many suggestions for establishing linkages.

- Colleges, universities, technical institutes. Contact the engineering and science departments. Agriculture and forestry departments in these institutions may also have engineers and scientists. Admission offices should be able to suggest faculty, staff, or students. Ask if they have a Society of Women Engineers or any organization of women scientists. Admissions and placement offices may suggest alumnae. Even if a college or university is not in your immediate vicinity, State and private universities in other parts of the state may arrange for people to come to your school.

- Federal, state, and local governmental agencies dealing with technical or scientific issues -- e.g., environment, public works, energy, transportation, geology, weather, conservation. Government agencies dealing with employment or economic affairs can provide speakers and materials about your local labor market. Scan government listings in the telephone directory of the nearest major city (suburban directories are not likely to be good sources).

- Science museums may have traveling personnel or exhibits;

- Companies employing engineers and scientists. Identify them through Help Wanted ads, or inquiring of the Chamber of Commerce. Search for classified telephone directory listings under such headings as Engineers, Data Processing, Chemicals, and Electronics. Public utilities companies often have special educational programs. The Bell System has special programs -- check with the business manager in your community.

- Organizations of volunteers, such as:

  women's groups: League of Women Voters, NOW, American Association of University Women;

  youth groups -- Girl Scouts, 4-H, and other organizations sponsor career exploration programs;

  environment/conservation groups, such as the Audubon Society, Sierra Club;

  professional and technical engineering and science societies, such as the Society of Women Engineers can recommend women members. See the Occupational Outlook Handbook and special publications listed in Pamphlet 2, for names of national organizations that may have chapters in your town;

personnel and placement organizations. Organizations of personnel people and organizations that recruit engineers and scientists should be helpful.

b) Request help from these individuals.

It takes a certain amount of nerve to initiate contacts with strangers in organizations that seem large and impersonal. To reassure those who may be uneasy about their first step, it is likely that most organizations in your community want to extend their resources to benefit schools. In addition, the special concern of employers about increasing the participation of women in scientific and technical careers, occasioned both by personnel shortages and affirmative action programs, creates added incentives for them to contribute to school programs.

You can "cultivate" an ally in whatever organization you contact by explaining your objectives in detail either by phone or in a personal visit and asking for aid in identifying women engineers and scientists for school programs. Many men who are scientists and engineers are willing to support such activities. Your inital

contact should be with someone as high up as possible in personnel, corporate relations, or affirmative action. (Different organizations may vary the names of these departments.) In turn, that person can refer you to others. There is an important practical advantage in requesting recommendations from a "higher up." A woman scientist or engineer who participates will then have approval for taking time off rather than having to request time for personal leave; this might otherwise be an obstacle to her participation.

Give the company a few weeks' notice because lead time is necessary to identify the right people to participate. You should record the effectiveness of various speakers so that you can capitalize on people's talents and decide whom to invite back for future programs. To reduce mishaps and build good will, confirm all arrangements by letter and follow up with thank you letters after any event. Of course, involving students in planning and letter writing motivates them, and their participation is gratifying for the women engineers and scientists.

Do not be discouraged when you discover that it takes many phone calls and visits to establish a program of activities. Develop a network so that you do not overtax any one company or person. Forming an advisory group of parents and community representatives can complement efforts of teachers and counselors and become an important support group.

c) Plan specific activities in which women engineers and scientists participate, such as:

- Speaking to a class, a club, an informal group. Organizations generally permit employees to take two or three hours to speak to high school students. A teacher, counselor, or responsible student briefs the speaker well ahead about the student group -- their age, interest, and subject matter and briefs the group about the speaker after asking the speaker to send information about her company for advance discussion. Speakers should bring either written material and/or a sample product and should be as informal as possible so that students feel comfortable about asking questions.

- Responding to students' telephone interviews about their careers for subsequent reporting to a class or group. Teachers or counselors can work with students to plan questions that illuminate the process of choosing a career, the nature of jobs and the personal issues.

- Arranging for site visits. Visiting a work site or a college provides a realistic sense of work and education in engineering and science. However, some companies may invite educators but not students; others may prefer only specially selected students. Visits should be carefully planned to fit students' interests and industry

preferences and should provide time for meeting with women engineers and scientists. Site visits might be a group tour of one to two hours; or, individual experiences "shadowing" women engineers or scientists for one to several days. When you visit a company, you usually cannot "see" the work of engineers and scientists directly since they often work at desks or in laboratories. A visit to a manufacturing company will provide a view of production that is based upon science and engineering research and development. Engineers and scientists can explain this to students.

Remember that prior and follow-up reading and classroom discussion will enlarge the value of site visits. Let your industry hosts know that the aim is to expose possibilities to young women, not to have them choose a specific career and remind them that talks should be in simple non-technical language with opportunity for questions.

Companies or colleges may also provide internships. These would be summer or vacation experiences where a work assignment is given to a young person under close supervision of a woman employee. This takes long-range planning.

Help Women Plan for College

Who should prepare for careers in engineering and science in our democratic society? No simple recipes exist for designating who should and who should not. Not only do engineering and science careers encompass a broad range of jobs, but also adolescents grow and change in marvelous and

unpredictable ways. Some teenagers who have previously seen no use for mathematics might decide to master it when they realize its importance. Also, we see over and over that contemporary women aware of expanding options, modify their plans as they mature. Hence, educators and parents should provide encouragement, guidance, and exposure so that many young women perceive opportunities and can comfortably "select" themselves as candidates for becoming engineers or scientists. What women require is sufficient awareness of educational and employment possibilities to ask questions that will help those with requisite abilities to decide for themselves.

Students who want to enter an engineering school or plan to major in science will require good preparation in mathematics, physics, and chemistry in addition to courses in English and social studies. Though not required for college admission, computer and shop courses are also desirable.

Mathematics is essential for most careers; it is one of the most important tools of the engineer and of the physical scientist. Ideally, students should

be prepared to begin first-semester calculus in college having had sound training in high school algebra, geometry, and trigonometry. This is explained in Math Needs of Prospective Students in Engineering and Science, (Engineering Publications Office, 112 Engineering Hall, University of Illinois, Urbana, Illinois 61801).

However because of the distressing reality that too few students altogether elect advanced mathematics and physical science courses, and that some high schools may not even offer such courses, students may not have the necessary prerequisites when they graduate from high school. These students may think they cannot consider college while others may be discouraged about college because of financial difficulties. Colleges offer summer programs where students can take prerequisite courses. Many colleges also plan with students for financial aid through scholarships, loans, and work/study arrangements. Counselors should urge students not to eliminate themselves but rather to talk over all such questions with admissions officers.

One major decision confronting college applicants considering science or engineering will be whether to apply to an engineering school or a liberal arts college. Women students should recognize that a strong background in mathematics and science whether acquired through an engineering or a science major keeps options open. Generally, engineering schools and liberal arts colleges do not require students to declare their majors until the sophomore year of college, and even then changes can be made provided students have taken college mathematics, physics, and chemistry. A major in mathematics or physical science is considered to be good preparation for graduate work in engineering, medicine, law, and social science. Indeed, graduate departments and professional schools in most fields tend to look favorably upon students with strong undergraduate education in science, mathematics, or engineering.

A Bachelor's degree in engineering is considered a professional degree, though it is often followed by advanced study. Working for a Bachelor's degree in science exposes students in more depth to a

particular science area. Those students who ultimately want to do basic science research or prefer to postpone engineering until their graduate studies may prefer a liberal arts college. In recent years, increased enrollments in engineering have made transfers from liberal arts into engineering more difficult than the other way around.

About 275 colleges or universities offer Bachelor's degrees in engineering. Engineering schools include liberal arts courses as well as technical courses in their curricula. Engineering 1980, Engineering Guidance and Counseling is a compilation of articles with more details about high school and college preparation. It can be obtained from the Accreditation Board for Engineering and Technology, Inc., 345 E. 47th St., New York, N.Y. 10017. A much larger number of colleges and universities offer liberal arts undergraduate majors in mathematics, chemistry, physics, and related physical sciences. Both engineering schools and liberal arts colleges offer computer-related majors.

Perusal of college catalogues will enlighten students about the great variety of possible college

majors in engineering, physical sciences, mathematics, and computer and information sciences. Pamphlet 2 provides an overview of the major occupations in these areas and of sources of additional career information.

Many other colleges and business-operated schools offer one to four year programs for engineering technologists and technicians to prepare for jobs somewhere between those of a crafts person and an engineer. Often, these programs are developed in close liaison with industry. The level of mathematics and science is different from that in a traditional engineering school, and there is more emphasis on practical learning.

Some junior and community colleges and undergraduate liberal arts colleges have formed relationships with engineering schools that combine two years at the college with two to three years in an engineering program.

The alternative educational options mean that it is almost never too late to change course, albeit with some hardship. In recent years, some women who lost jobs or "burnt out" as nurses, secretaries, or

teachers have moved into technical fields but had to make up for their educational deficits in mathematics and science.

Find Out About the Participation of Women Students in Mathematics, Physics, and Chemistry in Your School

If possible, organize a working committee of teachers, parents, administrators, and counselors to study and design strategies for change in your school. As a basis for developing more effective strategies for increasing the number of women in these subjects, you will want to study the current situation. This may be easy or time-consuming, depending upon whether or not your school system collects enrollment data by sex and race. (Some schools collect enrollment data that includes race and ethnic identity but does not designate the sex of students.) The following paragraphs suggest some items to include, but, of course, you will adapt this to your unique situation.

a) What are the male and female enrollments in mathematics, science, and industrial arts courses and in related extracurricular activities?

b) What are the career plans of current men and women students?

c) What activities/programs have teachers or counselors planned in the past two years relating to careers in technology and science and applications of math and science. You might survey other local schools to exchange information.

d) Have teachers, counselors, and administrators had previous opportunities for learning about careers in technology and science, utilizing career information?

e) Have women role models in engineering or science participated in programs at your school in the past two years?

f) Does some person have responsibility for linking education and employment at your school?

Plan In-Service Programs

Your findings and the suggestions presented here can provide a basis for in-service programs both to educate faculty about technological and scientific careers and to plan for changes based upon knowledge of your school and community. Here are some simple examples:

Data about your school may reveal that significantly more young men than young women are in physics and chemistry courses or in an after-school mathematics club. Faculty members could evolve schemes to use women enrolled in those courses to

recruit their younger schoolmates by visiting biology or algebra classes; otherwise these may be the last mathematics or science courses that girls take. Young women who are not too distant in age and experience may be more influential recruiters than adults. "Minority" women may need special encouragement, whether their minority status is based upon race, ethnic group, or a handicap.

When you establish linkages with employers, a good way to begin is to invite representatives to meet with faculty members at your school or at their companies to provide "previews" of possible events for women students. Some companies may consider internships for teachers or counselors so that you can be "immersed" in the world of work and thereby be better prepared to convey career information. Some companies believe that they should limit their resources to working with educators who can in turn affect many more students than those who can visit companies.

Speakers from community groups particularly concerned about employment opportunities for women might participate in considering with you what

attitudes and behavior may limit women's options. Because of our own socialization, most of us, whether counselors, teachers, or parents may not be aware of the subtle ways in which we fail to capitalize on opportunities to motivate young women. Frank discussion among faculty and students can avoid perpetuating out-dated stereotypes about men's and women's work and family roles and can contribute to enriching the school environment for everyone.

The following sources can provide guidelines for in-service programs: Equals Project, Lawrence Hall of Science, University of California, Berkeley, CA 94720. Request the 1979 handbook describing workshops for teachers to foster mathematics and career preparation. WITS (Work in Technology and Science), Massachusetts Institute of Technology, 20C-228, Cambridge, MA 02139. Request the 1980 report, Work in Technology and Science: Linking Education and Employment, describing an in-service program for the Boston schools utilizing local technological companies. Pamphlet 2 includes additional sources of information about programs.

An Overview of Science and Engineering Careers

Engineers, Scientists, and Societal Problems

Physical, Environmental, and Mathematical Occupations

Engineering Occupations: Major Fields

Emerging Fields in Engineering and Technology

The Computer Revolution

Sources of Information about Careers and the Education and Employment of Women

DESCRIPTION OF THE PACKET

The packet includes three pamphlets that together provide information and suggestions intended to make it easier for counselors and teachers to encourage young women to consider science and engineering careers. A special flyer for students is also included to answer some important questions young women ask.

Pamphlet 1. What Can Counselors and Teachers do to Encourage Young Women Counselors and teachers play significant roles in young women's lives. Here are suggestions based upon others' experiences that can aid in developing a more supportive environment for women students.

Pamphlet 2. This has two parts. 1) An Overview of Science and Engineering Careers 2) Sources of Information about Careers and The Education and Employment of Women. This pamphlet provides brief descriptions of the range of career choices in engineering and the physical sciences, with special attention to the computer revolution. Although the life sciences are not included in this presentation, they also require basic preparation in the physical sciences and mathematics. The second part includes useful references for those seeking authoritative and inexpensive information.

Pamphlet 3. Especially for Women Students: Facts, Fiction, and Fun Reading about Science and Technology Here is an exciting bibliography that counselors and teachers can present to women students -- even those who may not think they are particularly interested in science.

The emphasis in this packet is on career prospects, but preparing for future employment should surely not be the only reason for selecting a course of study. For one thing, the future demand for particular kinds of workers is unpredictable. But, even more significant, as no one knows better than counselors or teachers, instilling a love of learning is the best foundation for evolving a satisfactory life plan.

This project was initiated by members of The Committee on the Status of Women in Physics of the American Physical Society because of their desire that young women discover the excitement and opportunities in the fields of physical science and engineering. Edith Ruina prepared the packet, drawing upon several years of experience as Director of WITS (Work in Technology and Science) at the Massachusetts Institute of Technology.

Since we are concerned about the age group that is in transition from childhood to adulthood, we resolved the delicate terminology problem by sometimes referring to "girls" and sometimes to "young women."

Edith Ruina
Cambridge, Mass.
April 1981

ENGINEERS, SCIENTISTS, AND SOCIETAL PROBLEMS

The National Science Foundation 1980 report, The Five-Year Outlook: Problems, Opportunities, and Constraints in Science and Technology, describes the range of societal issues that call for scientific research and engineering applications:

- Problems of energy supply and understanding of risks
- Assuring a supply of essential nonfuel materials -- metals, alloys, other specialized materials
- Improving transportation
- Deciding how to get the greatest scientific, technological and social return from space research and development
- Maintaining agricultural productivity with minimum use of fuel and in ways that are environmentally acceptable
- Greater understanding of biological and social bases of disease and behavior
- Understanding and minimizing natural and manmade environmental hazards
- Enhancing computer hardware and software to improve productivity while assessing the long-range effects upon society

Scientific research is necessary to provide the basic understanding about the nature of matter, the universe, life, and human society. However, it is often undesirable to direct and/or impossible to predict where research will lead. For example, polio vaccine, the laser, transistors, and integrated circuits were unforeseen results of basic research. Even when a sufficient scientific base is

established, it takes about a decade to initiate and carry a development to completion.

Most technological innovations that will be available in five years are already in an advanced stage of development. And, even when a new technology seems promising, its development and exploitation depends upon a host of individual and institutional factors. For example, national policy decisions about defense and arms control, energy, or space affect the chemical, aerospace, electronics, and nuclear industries, all of which are major employers of engineers and scientists. As little as ten years ago, however, it would have been impossible to forecast the extent of the computer revolution and consequent personnel needs. Moreover, many job openings are due to the need to replace people who retire, die, or move to other jobs; this means that the larger a field, the greater the number of likely employment openings. Hence, students should learn about the complexity and uncertainty of labor market projections so as to recognize the importance of decisions that permit adapting to changes.

A 1980 U.S. Commerce Dept. report, Learning Environments for Innovation, suggests new ways that schools, museums, and the media can aid in developing human resources for scientific and technological endeavors and thereby contribute to maintaining a high level of productivity.

The following overview of occupations includes first the major physical, environmental, and mathematical occupations; next, the major engineering occupations plus special attention to emerging occupations including those related to computer technology. Most of the following information is derived from the 1980-81 edition of the Occupational Outlook Handbook that includes 1978 labor market data:

PHYSICAL, ENVIRONMENTAL, AND MATHEMATICAL OCCUPATIONS

The major occupations are briefly described. However, each has sub-specialties, including occupations that span more than one discipline.

How Many People Work in These Occupations?

Physical Scientists

Chemists	143,000
Physicists	40,000

Environmental Scientists

Geologists	31,000
Geophysicists	11,000
Meteorologists	7,000
Oceanographers	3,600

Mathematics Occupations

Mathematicians	33,500
Statisticians	23,000

What Is Their Education?

Many scientists who work in research and teaching require graduate degrees. However, chemists, statisticians, geologists -- more so than others -- can find entry level jobs in industry with Bachelor's degrees. All of the occupations mentioned here require strong undergraduate preparation in chemistry, physics, and mathematics.

What Do They Earn?

In 1978, scientists and mathematicians with Ph.D.'s started with salaries in the range of $19,000-$23,000. Those with Bachelor's degrees started at $13,000-$15,000; but, geologists with Bachelor's degrees received higher beginning salaries.

The Major Fields and What People Do

Chemistry

Work done by chemists contibutes to the clothes we wear, our housing and food, medical care, and a cleaner environment. About half the chemists work in the chemical manufacturing industry, and the rest are scattered throughout other industries and in colleges and universities. Chemists search for, analyze, and put into practical use knowledge about new materials.

Chemical research has resulted in the development of antibiotics, chemical processes which help save energy and reduce pollution, as well as a tremendous variety of synthetic materials such as plastics. Nearly one-half of all chemists work in research and development, others work in production, marketing and sales, or teach.

Physics

Our understanding of space and of the ocean depths and even the safety of the family car depends upon physics. Through systematic observation and experimentation, physicists attempt to describe and understand the structure of the universe and the basic interactions of matter and energy. Determining the underlying laws governing such phenomena as gravity, electromagnetism, and nuclear interactions leads to scientific progress in areas such as nuclear energy, electronics, communications, aerospace, and medical instrumentation. The majority of physicists work in research and development. The instrumentation that they design for their basic reseach can often be applied to other areas -- e.g., lasers are used in surgery and microwave devices are used for ovens. Research work in solid-state physics led to the development of transistors and microcircuits now used in electronic equipment for everything from hearing aids to missile guidance systems.

Growing numbers of physicists are specializing in fields that combine physics and a related science such as astrophysics, biophysics, chemical physics, and geophysics. Graduate training in physics or a closely-related field is almost essential for most entry level jobs in physics. In 1978, private industry employed over one-half of all physicists, primarily in companies manufacturing chemicals, electrical equipment, and aircraft and missiles. Almost one-half of all physicists taught or did research in colleges or universities. Others worked in national laboratories, in independent research organizations, and in hospitals.

Geology and other environmental sciences

Geology is the largest of the environmental sciences and is concerned with understanding the history, composition, and characteristics of the earth's surface, interior, and atmosphere. Some geologists explore for new sources of oil and other minerals. Others examine surface rocks and drill to recover rock cores so as to determine the types and distribution of rocks beneath the earth's surface. They also identify rocks and minerals, conduct geological surveys, draw maps, take measurements, and record data. Some geologists' work is directed towards understanding earthquakes and volcanos. More than three-fifths of all

geologists work in private industry for petroleum and mining companies and for contruction firms. Others work for the Federal and State governments. A Bachelor's degree in geology or a related field is adequate for entry into some geological jobs. The employment outlook is good.

Other interesting branches of Environmental Science which employ fewer people include meteorology and oceanography. These environmental fields also offer many opportunities for engineers -- see the discussion of Emerging Fields

Mathematics

Mathematicians work in one of the oldest and most vital of all disciplines. Some concentrate on developing new principles and theories that may or may not have practical use but add to abstract knowledge. Applied mathematicians develop theories, techniques, and approaches to solve practical problems in business, government, engineering, and the natural and social sciences. In fact, the number of people who depend upon mathematical expertise for their work is many times greater than the number designated as mathematicians: for example, people in occupations such as actuary, statistician, computer programmer, systems analyst, and operations research analyst. Every scientific and technical field requires strong undergraduate college

preparation in mathematics. About three-fourths of mathematicians in 1978 worked in colleges and universities. In the private sector, the major employers were the aerospace, communications, machinery, and electrical equipment industries. The Defense Department and NASA employ most mathematicians who work for government.

Statisticians devise, carry out surveys and experiments, and analyze and interpret their numerical results. They usually apply their special knowledge of statistics to a particular subject area such as economics, human behavior, natural science, or engineering. They make predictions about future trends and supply information to business managers and government officials that enables them to make decisions and evaluate programs. Over half of all statisticians work in private industry, primarily in manufacturing, finance, and insurance companies. Several fields use statistics to a great extent -- marketing research, urban planning, engineering and science, social science, actuarial and financial analysis, computer programming, and systems analysis. College graduates who know statistics and some major area of application such as economics or natural science, and students who combine statistics with knowledge of computers will be in great demand.

ENGINEERING OCCUPATIONS -- MAJOR FIELDS

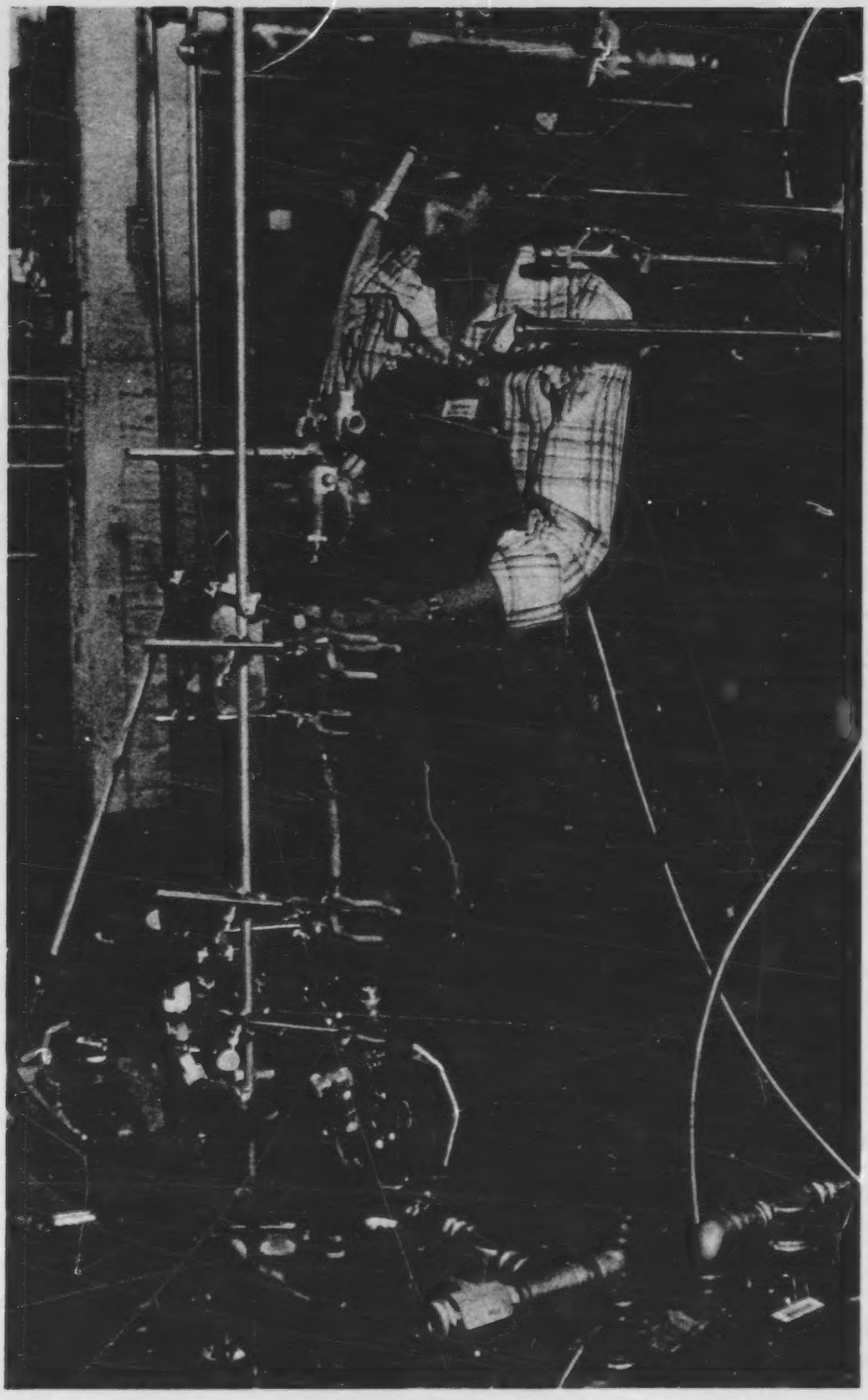
There are over 1,000,000 engineers in the U.S. In the category of professional and technical occupations, engineering is second only to teaching. The major areas of engineering are briefly described. However about 25 specialties are recognized by professional engineering societies.

How Many People Work in Engineering Occupations?

Electrical	300,000
Mechanical	200,000
Industrial	185,000
Civil	155,000
Aerospace	60,000
Chemical	50,000
Petroleum	17,000
Metallurgical	16,000
Mining	6,000
Engineering and Science Technicians	600,000

What Is Their Education?

A Bachelor's degree in engineering is the accepted entry requirement. Bachelor's degrees in other physical or mathematical sciences may qualify people for beginning jobs. Master's and Ph.D. degrees enable engineers to do higher level research and development, and also to teach in universities.



What Do They Earn?

In 1978, engineers with Bachelor's degrees started at salaries in the range of $16,000-$20,000.

The Major Fields and What People Do

Electrical

Electrical engineers design, develop, test, and supervise the manufacture of electrical and electronic equipment. Electrical equipment includes power generating and transmission equipment. Electronics equipment includes radar, computer, and communications equipment, and consumer goods such as television and stereo sets. Electrical engineers also design and operate facilities for generating and distributing electric power. Electrical engineering is the largest branch of the profession. Most electrical engineers work for equipment manufacturers. Many work for telephone, telegraph, light, and power companies. Others are employed by government agencies, colleges, and universities.

Industrial

Industrial engineers are more concerned with methods of business organization than are engineers in other specialties, who are more concerned with particular products

or processes. They may design a better process or method of doing something, recommend design and purchase of particular kinds of equipment or the development of a plant layout that will best utilize equipment and people. They need to know mathematics, physics, and production methods, as well as psychology, sociology, and economics.

Mechanical

Some mechanical engineers design and develop machines that produce power: internal combustion engines, steam and gas turbines, jet and rocket engines, and nuclear reactors. Other mechanical engineers work with machines that use power such as refrigeration and air-conditioning equipment, elevators, machine tools, printing presses, and steel rolling mills. Job opportunities exist in most industries. Newer areas of work in environmental protection, and atomic and solar energy will also provide opportunities.

Civil

Civil engineers design and build roads, buildings, harbors, airfields, tunnels, bridges, water supply, and flood control systems. Most work for Federal, State, and local government agencies or in the construction industry. Many work for consulting engineering and architectural firms

or as independent consulting engineers. Others work for public utilities, railroads, educational institutions, and manufacturing industries. Job opportunities will result from the growing needs for housing, industrial buildings, electric power generating plants, transportation systems, and for solving problems of environmental pollution.

Chemical

Chemical engineers are involved in many phases of the production of chemicals and chemical products. They design and test equipment and chemical plants and manufacturing processes. They develop chemical processes such as those to remove chemical contaminants from waste materials. Because the duties of chemical engineers cut across many fields, these professionals must have a knowledge of chemistry, physics, and mechanical and electrical engineering. Most chemical engineers work in manufacturing industries, primarily those producing chemicals, petroleum, and related products. The growing complexity and automation of chemical processes plus the need for environmental protection, development of synthetic fuel, and the design and development of nuclear reactors will require additional chemical engineers.

Aerospace

Aerospace engineers design, develop, test, and help produce commercial and military aircraft, missiles, and spacecraft. They work mainly in the aircraft and parts industry.

Petroleum

Petroleum engineers are mainly involved in exploring and drilling for oil and gas. They determine and develop the most efficient production methods. They work for oil companies, for companies that produce drilling equipment, and for financial institutions determining the economic value of oil and gas properties.

Metallurgical

These engineers develop new types of metal and new methods for converting metal into useful products. Scientists working in this field include metallurgists or material scientists doing similar work. The iron, steel, and nonferrous metals industries employ most of these people. Others work in industries that manufacture machinery, electrical equipment, aircraft and parts, and in mining. An increasing number will be needed to develop new metals and alloys for communications equipment, computers,

and spacecraft and to deal with recycling solid wastes and problems of nuclear energy.

Mining

Mining engineers find, extract, and prepare minerals for manufacturing industries to use. They are usually employed at the location of mineral deposits, but some work in other locations doing research, teaching, consulting, or sales work.

Engineering and Science Technicians

They are the people who complement the work of engineers and scientists by drafting, designing, setting up experiments, testing, and inspecting products. Some technicians become engineers by working and also continuing their education financed by employer-supported tuition reimbursement plans, an interesting alternative way to pay for college. Few women are engineering and science technicians, and job prospects are good for those with proper qualifications.

EMERGING FIELDS IN ENGINEERING & TECHNOLOGY

What about students who would like to specialize in environment, conservation, finding new sources of energy and

food, computer, or oceanography? Many young people concerned about energy, the environment, and health care do not realize that engineering can be the most useful path into work on these problems. Mostly, engineers train in one of the major fields of engineering and then adapt their education and experience to the solution of new problems. But, as problems become better identified, new educational and job specializations develop as well. New specializations that are becoming possible college majors follow. Since these are still small fields, before choosing one of these, students should consider broad science or engineering preparation with later specialization.

Environmental Engineering

Two hundred colleges awarded degrees in environmental engineering in 1978. In addition, many colleges offered degrees in closely allied fields such as biology, biochemistry, ecology, oceanography, industrial hygiene, health physics, radiation protection, and safety engineering. Environmental engineers design, operate, or manage facilities and systems for environmental protection, including testing air quality, the storage and transportation of chemicals, and record keeping related to environmental problems.

Biomedical Engineering

Usually the biomedical engineer has a degree in one of the basic engineering disciplines and then goes on for a graduate degree in this area. Biomedical engineers work with life scientists, chemists, and the medical profession. They design medical instruments and devices such as artificial limbs and organs, lasers for surgery, and pacemakers. They adapt computers to various medical uses, and design and build systems to modernize laboratory, hospital and clinical procedures. Most of them teach and do research, but some work for the government and for private industry developing new health-care devices, techniques and systems. This is likely to be a growing field, but a small one (4000 in 1978).

Ocean Engineering

This began in the early 60's as a result of growing awareness of sea resources -- oil, tidal power, food, and transportation. Ocean engineers work for defense industries building sonar systems, for oil companies on offshore rigs, and for state, local, and federal government agencies. They design and build instruments for oceanographic research and work with oceanographers and other scientists. New specialities within ocean engineering are emerging to which the federal government has given impetus. Information can

be obtained from Director, Office of Sea Grant, NOAA (National Oceanic and Atmospheric Administration), 6001 Executive Blvd., Rockville, MD 20852.

Energy Engineering

In 1978, about 12,000 of the 58,000 engineering graduates went into energy-related careers. Altogether, about 40,000 engineers are employed in the nuclear energy industry. Over 11,000 of them are mechanical engineers, 8,000 are electrical engineers, and the rest are chemical, civil, nuclear, and metallurgical engineers. Altogether, these engineers account for approximately 45% of the nuclear industry work force. Over half of them work in research and development; many work in reactor manufacturing, operations and maintenance, nuclear medicine, and nuclear power plants. A number of colleges and universities offer BS programs specifically in nuclear engineering, and it is also possible to pursue graduate work in this area after a BS in engineering, physics, chemistry, or mathematics.

Solar Energy Engineering

People wishing to specialize in solar energy should pursue one of the traditional engineering disciplines with some specialized courses related to the solar field. Approximately 40% of the workers in solar research and

development are mechanical engineers, but the field will utilize electrical, design, environmental, civil, and architectural engineers as well.

Technology, Science, and Public Policy

The increasing recognition of the social impact of science and technology has fostered the growth of interdisciplinary research and programs involving physical, life, and social scientists. Students with an interest in public policy who have science and engineering, or social science backgrounds can consider these areas of specialization.

Another emerging field -- computers -- is discussed next.

THE COMPUTER REVOLUTION

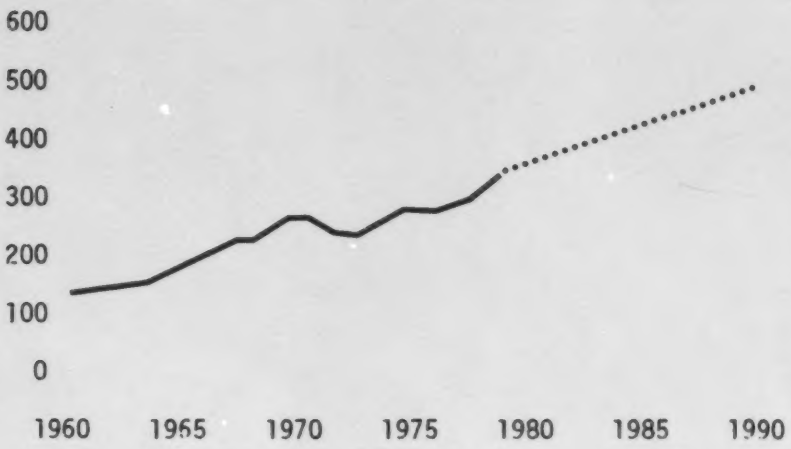
Any current discussion of technological and scientific careers must feature computer-related employment. The computer revolution is the result of basic research in semiconductors leading to increasing complexity and decreasing costs of semiconductor chips. Computers are now used to control manufacturing processes, simulate tests, store information, and play games. Computers play a larger and larger part in every job, school, and home.

Computer Manufacturing

In the past several years, the growth of the computer manufacturing industry has been extraordinary as can be seen in the following chart:

EMPLOYMENT IS EXPECTED TO GROW RAPIDLY IN PLANTS THAT PRODUCE COMPUTERS AND RELATED EQUIPMENT.

Office and computing machine manufacturing workers (thousands)



Source: Bureau of Labor Statistics -- Occupational Outlook Handbook, 1980-81 Edition.

The engineers and scientists in the computer manufacturing companies include electrical or electronics engineers (the largest number), mechanical engineers, industrial engineers, chemical engineers, chemists, physicists, mathematicians, and statisticians. These people participate in research and development of materials and

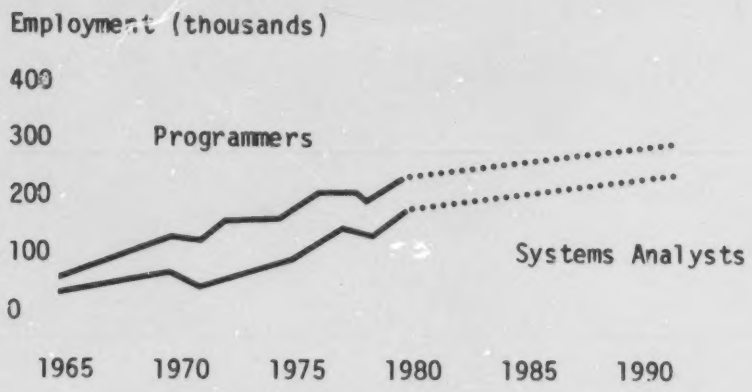
EXIT

parts to assure technological advances in hardware -- the production of computers and related equipment, and in software -- the design of computer operating systems and of programs for new uses. The engineers and scientists who participate in the design and development of hardware or software need strong mathematical and physical science preparation. Special courses of college study are being developed in computer science. These permit students to build careers in advanced computer systems development, in sophisticated applications of computers to technical organizational problems, and in the further development of computer science. Systems analysts and programmers who devise new information processing techniques need scientific or engineering backgrounds as well as knowledge of program languages.

Computer Applications.

Here a computer -- there a computer -- everywhere a computer. Computer users require systems analysts and programmers in greater and greater numbers to handle all kinds of information. Organizations including manufacturing companies, school systems, government, hospitals, banks, insurance companies, etc., use computers for business applications. As the technology advances and becomes less expensive, computer use increases.

EMPLOYMENT OF PROGRAMMERS AND SYSTEMS ANALYSTS, NEGLIGIBLE IN 1960, IS EXPECTED TO EXCEED HALF A MILLION WORKERS BY 1990



Source: Bureau of Labor Statistics -- Occupational Outlook Handbook, 1980-81 Edition.

Systems analysts working in business applications figure out what data needs to be collected, what is suitable computation equipment, and the steps to be followed in processing information. Programmers work from problem descriptions prepared by analysts. For business applications, firms prefer people with college degrees in accounting, business, or economics. Since the need for trained people has expanded so rapidly, some firms may be willing to hire and to train people without college degrees who demonstrate programming aptitude.

Those who are employed in business applications in data-processing firms or in manufacturing companies earn more than those in insurance companies or educational institutions. Those who combine a computer background with a background in a major substantive field are eagerly sought.

People who enjoy technology and dealing with people can become effective links between manufacturers and users of computers in a variety of jobs such as marketing and sales or technical writing. Young women should be aware that the computer itself is changing the nature and number of many jobs in manufacturing and in offices.

SOURCES OF INFORMATION ABOUT CAREERS AND ABOUT THE EDUCATION AND EMPLOYMENT OF WOMEN

Information about engineering and scientific careers and about opportunities for women exists just about everywhere. Sources suggested here can be used for research projects about engineering, science, economics, and career planning and can become the subject of social studies reports, mathematics problems, bulletin board displays, and guidance discussions . The material suggested is free or available for a small charge.

Libraries

Libraries are gold mines and enthusiastic librarians help teachers and students ferret out facts, fiction, fantasy, and excellent federal publications. The exciting student reading list in this packet suggests books to purchase to "turn on" young women. (All are included in Books in Print.) Throughout the packet are many other references about careers, preparation for them, and sources of information.

The U. S. Department of Labor, Bureau of Labor Statistics (BLS)

The BLS is the major collector and distributor of data on working Americans. Many of their publications are for public education: they are easy to read and attractive.

Regularly up-dated lists of their publications and flyers with price and ordering information can be obtained from the BLS national and regional offices. Ordering information is also included in BLS publications. Libraries also have these publications. BLS publishes many reports relating to women and employment. Some of the BLS publications are as follows:

The Occupational Outlook Handbook, published annually, describes jobs, preparation required, earnings, location, and future prospects for hundreds of occupations. Descriptions include names and addresses of professional, trade, and union organizations that can provide additional information. These sources could also give information about women in their fields and special publications for women. All sections are available in reprint form and are inexpensive so that it would be practical for teachers to have them. The following reprints relate particularly to engineering and science:

#2075-19 Environmental Scientists & Conservation Occupations
#2075-20 Engineering & Related Occupations
#2075-21 Physical & Life Scientists
#2075-22 Mathematics & Related Occupations

Exploring Careers is specifically for junior high-aged students. It includes narratives about people in various careers. It is also available as 15 separate booklets (one for each chapter).

A Counselor's Guide to Occupational Information describes hundreds of federal publications on jobs and careers including names and addresses of state and federal agencies. One section is devoted to publications about women.

Newspapers

"The New York Times" has a special science section each week. Other newspapers have frequent news, feature articles, and career information related to science and engineering. The business sections of most newspapers have articles about technology and technological companies. The Want Ads feature advertisements for engineers and scientists. If you are in an area without major employers of engineers and scientists, obtain the Sunday want ads of the nearest large metropolitan area.

Television

Regular news broadcasts as well as "specials" on television often feature issues of science and technology and public policy issues such as those related to the arms race or energy, where technology is a major aspect. Also, advertisements on television display new technological products and could stimulate exploration.

Industry Publications

Major companies employing engineers and scientists publish annual reports, products reports, and career brochures that can be used as learning materials. These can be obtained by phoning or writing to the public relations or personnel departments of these companies. They are often beautifully illustrated reports for public relations purposes. In addition, several companies have developed attractive educational materials specifically for high school students that illustrate both men and women in work roles. A few specific examples follow:

Introducing...An Exciting New World: The World of Metallurgy & Materials Engineering, American Society of Metals, Career Development Office, Metals Park, Ohio 44073.

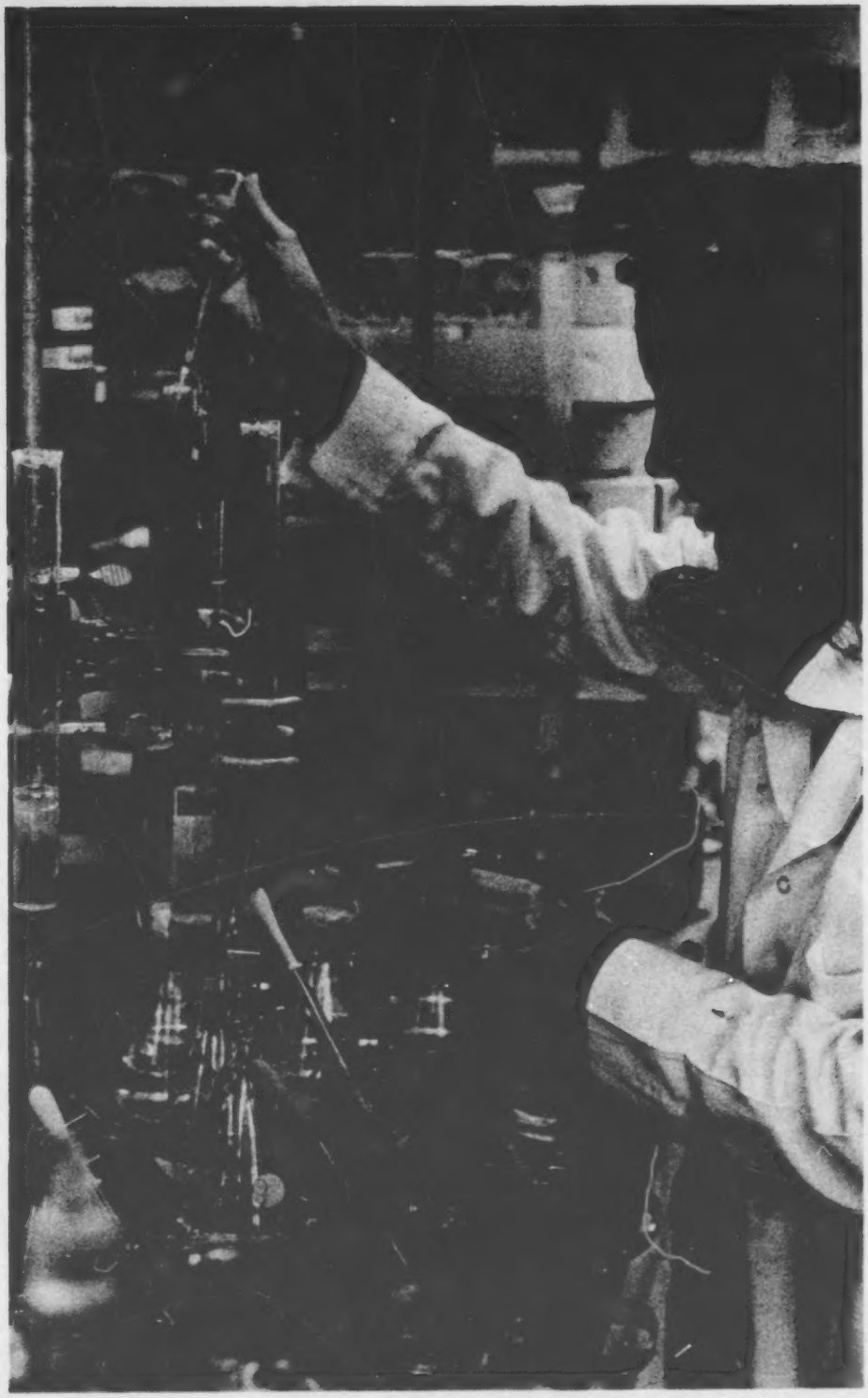
Take It From Us, You Can Be An Engineer; The World of Work; What's It Like To Be An Engineer; What's It Like To Be A Technician, General Electric Co., Communications Program, Fairfield Connecticut 06431.

Can I Get The Job?; Drafting--Can I Get The Job?, General Motors Corporation, Public Relations Dept., Detroit, Michigan 48202.

The Making of THE SEARCH FOR SOLUTIONS; The Reasons for THE SEARCH FOR SOLUTIONS, Phillips Petroleum Co., 708 Third Ave., New York, N.Y. 10017.

Choices, Decisions, Actions, Standard Oil Co. (Indiana), 200 E. Randolph Drive, P.O. Box 5910-A, Chicago, Illinois 60680.

Bell Systems -- check with the business manager of your local phone company for materials and speakers for schools, focusing on careers for women. Bell System can provide curriculum materials titled: Solving Problems: Engineers at Work.



The National Science Foundation, Science Education Directorate, Washington, D.C. 20550.

You can write for descriptions of programs they have supported which include several related to women plus publications related to science education. Science and Engineering Education for the 1980's and Beyond is a recent report about the need for all Americans to be educated in science. It can be ordered from the U. S. Government Printing Office: Bulletin #1980-0-334-588/6998. NSF projects are also included in ERIC.

The U. S. Department of Education

Funding has been available in several categories to support exemplary national, state, and local projects that address sex equity and options for women in scientific and technological careers. The office in your school that administers federal grants may help you locate information and also check with ERIC through your library. In addition, special funding has been available through the Women's Educational Equity Act Program. WEEA dissemination of educational materials is handled by the Education Development Center, 55 Chapel St., Newton, MA 02160. (Call toll free 800-225-3088.) Request Resources for Sex Equity, 1980-81 Catalog.

The U. S. Department of Labor, Women's Bureau, Washington, D.C. 20210.

Request Leaflet 10, describing publications of the Women's Bureau.

The National Institute of Education, Washington, D.C. 20208.

Its projects are described in Sex Equity in Education: NIE Sponsored Projects and Publications, February 1980.

National Science Teachers Association, 1742 Connecticut Ave., N.W., Washington, D.C. 20009

NSTA sponsors varied activities and publications for science teachers. Write for a list of publications. Some recent publications are as follows:

"Women in Science, Biographies for Young Readers," November/December 1980, Science and Children

NSTA Career Education News -- describes a special NSTA project.

Energy and Education -- includes a column on Careers in Energy.

Society of Women Engineers, 345 E. 47th Street, New York, N.Y. 10017.

They can suggest members (including college students) in chapters throughout the country and also provide attractive literature for young women.

American Association for the Advancement of Science, Office of Opportunities in Science, 1776 Massachusetts Ave., N.W., Washington, D.C. 20036.

The publication, Programs in Science, Mathematics and Engineering for Women in the United States 1966-1978, compiled by Michele L. Aldrich and Paula Quick Hall is an inventory of over three hundred projects for different age groups describing their objectives, program funding, and publications.

Some Examples of Publicatons for Young Women by and about Women Scientists and Engineers:

Women in Physics, American Physical Society, 335 E. 45th Street, New York, New York 10017. (Single copy free; multiple copies, 50¢)

I'm Madly in Love with Electricity, Nancy Kreinberg, Lawrence Hall of Science, University of California, Berkeley, CA 94720, ($2.00).

Space for Women: Perspectives on Careers in Science, Smithsonian Astrophysical Observatory, Att: Publications Dept., 60 Garden Street, Cambridge, MA 02138, (free).

Especially for Women Students: Facts, Fiction, and Fun Reading about Science and Technology

Featuring books that are visually arresting, imaginatively written, and interesting even for those who are not particularly attracted to science.

What's in store for you

Fiction
consists of science fiction novels and novelettes to appeal even to readers who are not sci-fi fans. For the most part, these titles are authored by women and feature strong female characters.

Women in Science and Technology
features biographies and works on individuals

Facets of Science and Technology
includes mixed and general titles.

The Earth:
devoted to the earth sciences, such as meteorology, paleontology, and geology

Numbers
presents in fun ways, mathematics, the language of science

Space:
looks at astronomy and other things, too.

Building:
engineering of houses, bridges, pyramids.

The World of Chemistry and Physics:
has titles about mechanics, too.

Basic Science Collection:
suggests a few to intrigue you.

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Pamphlet 2. This has two parts. 1) An Overview of Science and Engineering Careers 2) Sources of Information about Careers and The Education and Employment of Women. This pamphlet provides brief descriptions of the range of career choices in engineering and the physical sciences, with special attention to the computer revolution. Although the life sciences are not included in this presentation, they also require basic preparation in the physical sciences and mathematics. The second part includes useful references for those seeking authoritative and inexpensive information.

Pamphlet 3. Especially for Women Students: Facts, Fiction, and Fun Reading about Science and Technology Here is an exciting bibliography that counselors and teachers can present to women students -- even those who may not think they are particularly interested in science.

The emphasis in this packet is on career prospects, but preparing for future employment should surely not be the only reason for selecting a course of study. For one thing, the future demand for particular kinds of workers is unpredictable. But, even more significant, as no one knows better than counselors or teachers, instilling a love of learning is the best foundation for evolving a satisfactory life plan.

This project was initiated by members of The Committee on the Status of Women in Physics of the American Physical Society because of their desire that young women discover the excitement and opportunities in the fields of physical science and engineering. Edith Ruina prepared the packet, drawing upon several years of experience as Director of WITS (Work in Technology and Science) at the Massachusetts Institute of Technology.

Since we are concerned about the age group that is in transition from childhood to adulthood, we resolved the delicate terminology problem by sometimes referring to "girls" and sometimes to "young women."

Edith Ruina
Cambridge, Mass.
April 1981

A BIOGRAPHY OF THE BIBLIOGRAPHY

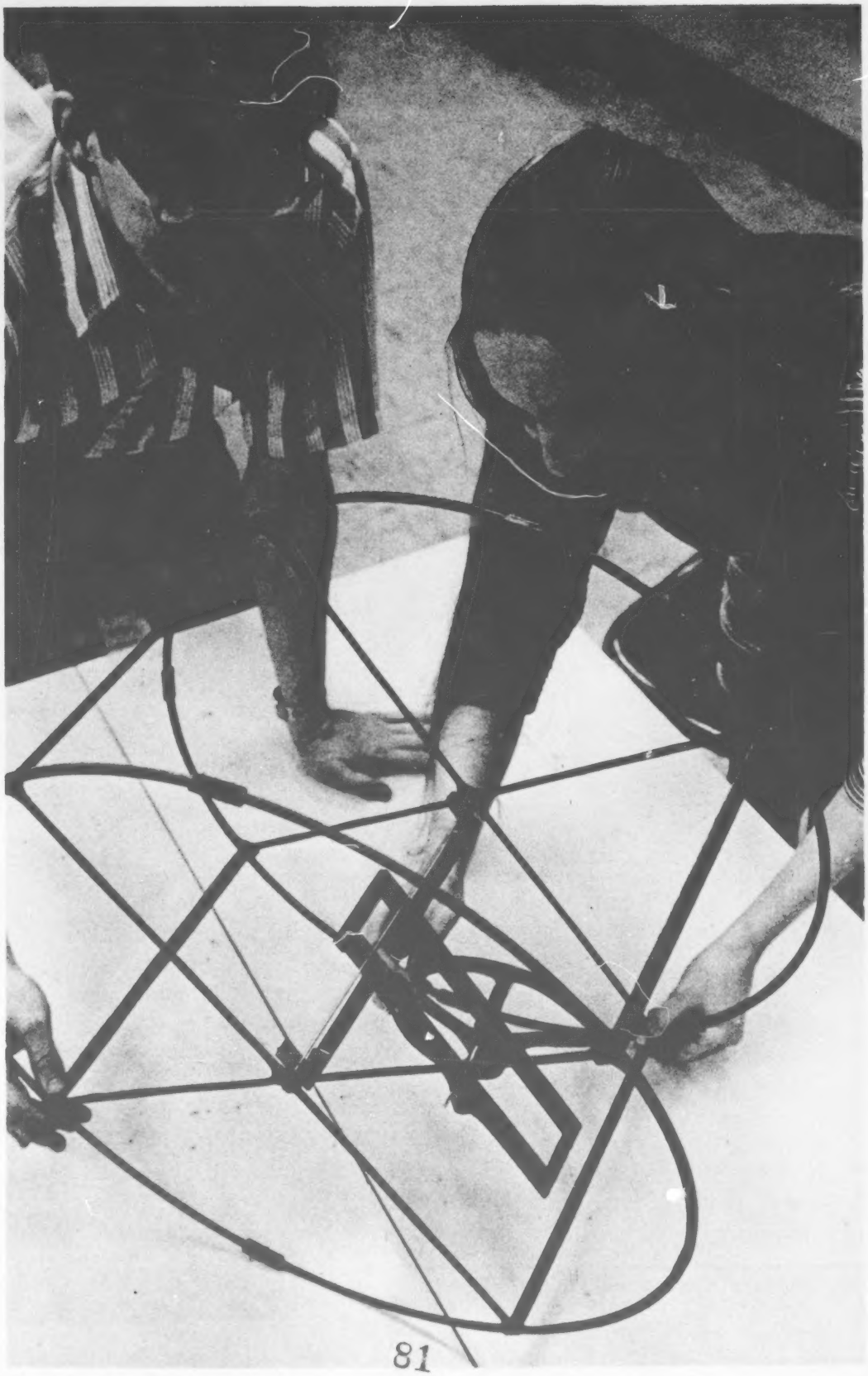
This annotated bibliography was created by Amy Rolnick and Kate Waters, who were recommended for the task by the Director of the Young Adult Section of the Boston Public Library. With loving care, they combed the shelves for current books that would "turn on" young women to the excitement of science and technology. They rejected books that made it seem that science was "for men only" even if they were otherwise well-written; they selected books that would appeal to young women deciding what to do when they grow up -- knowing from their own lives that that takes a combination of gravity and humor.

They were sad that few good books exist for non-professionals to communicate the nature of the computer revolution and other engineering innovations. But the consolation is that technological change is so fast and furious that it is featured in daily newspapers and on television.

Counselors and librarians like to be asked to help. If you suggest it, they might display these books on a special shelf. Books in Print provides purchasing information. Also, ask them about government and professional publications about careers for women -- for starters, they can steer you to "Scientific and Technical Occupations" in the Occupational Outlook Handbook and Exploring Careers.

"There is no frigate like a book," and we invite you to share in a voyage of discovery. The time for young women to explore the world of science and technology is now. Sail on into the list!

Edith Rubina
Cambridge, Mass.
April 1981



FICTION

Engdahl, Sylvia Louise ENCHANTRESS FROM THE STARS	Elana, as a student from the Federation's Anthropological center was not supposed to become involved in the fight to save the planet, Andrecia, from the Imperial Forces. But she did.
Hoover, H. M. CHILDREN OF MORROW	Tia and her brother, Rabbit, have always been different and the "race of man" seems to hate them for it. They are sustained in their flight from their grim home by their telepathic link with the powerful Ashira of Morrow.
Hoover, H.M. THE DELIKON	Varina has been on Earth too long instructing young students to find it easy to think of returning to her Delikon shape and home.
Hoover, H.M. THE LOST STAR	Lian Webster, a respected astrophysicist in her own right, becomes unexpectedly involved in an archaeological expedition. Through her telepathic link with the velvety gray lumpies, she uncovers the secret of a lost civilization on the planet, Balthor.
Hoover, H.M. TREASURES OF MORROW	In this sequel to Children of Morrow, Tia and Rabbit arrive in Morrow which they find a wonderful relief after living in nuclear-scarred Base. Here they learn to develop their powers.
L'Engle, Madeleine A WRINKLE IN TIME	A tesseract is a wrinkle in time. Meg, her brother, and a friend search for Meg's father, traveling through space and time to find him.
Sargent, Pamela ed. WOMAN OF WONDER MORE WOMEN OF WONDER	Science fiction novelettes by women about women.

Varley, John
TITAN

In orbit around the planet, Saturn, is Gaea, the Titan, -- an unbelievably huge creature. Captain Rocky Jones and her crew soon realize that what they have found is an artifact of alien intelligence.

Vinge, Joan D.
McIntyre, Vonda
Randall, Maita
THE CRYSTAL SHIP

Wonders and horrors await you as you travel through worlds of the future on the imagination of three women writers.

Wilhelm, Kate
JUNIPER TIME

When a drought forces the evacuation of the Western portions of the United States, and the people migrate eastwards, one woman, Jean Brighton, flees in another direction.

WOMEN IN SCIENCE AND TECHNOLOGY

Haber, Louise
WOMEN PIONEERS OF SCIENCE

Twelve women scientists, including a nuclear physicist, a bio-chemist, and a crystallographer: their lives, their work, their struggles, and triumphs.

Macksey, Joan
Macksey, Kenneth
THE BOOK OF WOMEN's ACHIEVEMENTS

Biographies of almost 1500 women in all fields including science, medicine, exploration, and technology.

Mozans, H. J.
WOMAN IN SCIENCE

From ancient Greece to the Victorian period, a history of women in mathematics, astronomy, physics, chemistry, natural sciences, medicine and surgery, archaeology, and as inventors. Although written 60 years ago, and scholarly at that, it is encouraging and sometimes spine tingling. What great women to know!

Noble, Iris
CONTEMPORARY WOMEN SCIENTISTS OF AMERICA

Joanne Simpson is a meteorologist; Estelle Ramey, an endocrinologist; Dixie Lee Ray, a marine biologist; Elizabeth Shull Russell, a geneticist -- who are they, how did they get started in their careers, what do they do?

Reid, Robert MARIE CURIE	Young and unknown, she discovered radium and eventually was the first person -- woman or man -- to win two Nobel prizes in science.
Ruddick, Sara Daniels, Pamela, eds. WORKING IT OUT	"23 women writers, artists, scientists and scholars talk about their lives and work.
Syre, Anne ROSALIND FRANKLIN AND DNA	Rosalind Franklin was one of four scientists whose work was most responsible for the discovery of DNA.
Van Lawick-Goodall, Jan IN THE SHADOW OF MAN	Many color photographs describe her life among wild chimpanzees. She became their friend and was accepted into their society.

FACETS OF SCIENCE AND TECHNOLOGY

Adkins, Jan INSIDE: SEEING BENEATH THE SURFACE	If you had x-ray eyes, these are some of the things you might see.
Asimov, Isaac ASIMOV'S GUIDE TO SCIENCE	A nontechnical guide to the physical and biological sciences with an appendix on mathematics in science.
Asimov, Isaac TODAY AND TOMORROW AND...	The mysteries of the biological clock, sports of the future, the importance to science of science fiction....these essays tell what we know, what we don't know, and what we may soon find out in biology, astronomy, chemistry, and physics.
Berger, Melvin CONSUMER PROTECTION LABS	Scientists in these labs set fire to nightgowns, test detergents on rabbit skins, and drop toasters off shelves. All of this strange activity has two purposes: to inform and protect the consumer.

Bova, Ben, ed.
THE ANALOG SCIENCE FACT READER

The pollution problem can be solved by moving all our industry off the planet; robots will soon be commonplace to us. Based on what's happening today in research laboratories, these essays look to the future.

Bova, Ben
SCIENCE -- WHO NEEDS IT?

Do you think that science and technology are destroying our world? This book passionately states science's value, power, and potential.

DeBono, Edward, ed.
EUREKA!

"An illustrated history of inventions from the wheel to the computer."

Duncan, Ronald
Weston-Smith, Miranda
THE ENCYCLOPEDIA OF IGNORANCE: EVERYTHING YOU EVER WANTED TO KNOW ABOUT THE UNKNOWN

"The usual encyclopedia states what we know. This one contains papers... on matters which are on the edge of knowledge." Like the solar interior, consciousness, pain, sleep, and quantum mechanics.

Haines, Gail Kay
BRAIN POWER

What is intelligence? What is creativity? How do you learn? Which side of your brain dominates your life? Read this, try out the puzzles, test yourself, and find out.

Keylin, Arleen, ed.
SCIENCE OF THE TIMES, 2

Recent advances in aeronautics and space, in energy and environment, in technology, in medical research. From the pages of the New York Times.

Medewar, P. B.
ADVICE TO A YOUNG SCIENTIST

Sir Peter shares advice and experience of the realities of life as a scientific researcher -- how you can tell if you're cut out for it, how to choose a subject to research, sexism, and racism in the field.

Silverstein, Dr. Alvin
Silverstein, Virginia B.
THE WORLD OF BIONICS

A whole new realm where biologists, physicians, engineers, and computer specialists get together to study and improve upon nature's devices for hearing, seeing, etc.

Waters, John F.
CRIME LABS

Solving crimes with science.

Pantini, Charles
BREAKTHROUGHS: ASTONISHING ADVANCES IN YOUR LIFETIME IN MEDICINE, SCIENCE AND TECHNOLOGY

A tour of the advances and breakthroughs predicted in your lifetime that will alter the way you live.

THE EARTH

Baird, David M.
OUR EARTH IN CONTINUOUS CHANGE

The Earth and what is done to it by the rivers and glaciers that flow along its surface, by the volcanoes that burst from within, by the oceans that leap at its shores.

Findley, Rowe
GREAT AMERICAN DESERTS

Full of boojum trees, road runners, and chuckwalla lizards, the ruins of great Indian civilizations and of course, cacti, four great deserts cover part of 10 states.

Gallant, Roy A.
EARTH'S CHANGING CLIMATE

Are we headed straight for another ice age? Or is the earth undergoing a warming trend which could cause the melting of the polar icecaps, and the flooding of cities like London, New York, and Tokyo?

Gribbin, John
WEATHER FORCE

Floods and freezes, droughts and famine, the earth is rocked by violent extremes in weather. Why?

Halacy, D. S. Jr.
EARTHQUAKES: A NATURAL HISTORY

From myths to recent disasters, with chapters on engineers who design buildings that can survive earthquakes, and the predicting and control of quakes.

Hotton, Nicholas III
THE EVIDENCE OF EVOLUTION

Focus of the paleontologists' study, fossils tell the story of evolution.

Lordway, Frederick I. III
PICTORIAL GUIDE TO
PLANET EARTH

See your city, the eye of a hurricane, the residue of industrial waste in the ocean, the course of the Mississippi (and much more) in pictures taken from satellites circling the Earth. Learn how oceanographers, geographers, geologists, agriculturalists, and meteorologists use these pictures.

McLoughlin, John C.
ARCHOSAURIA: A NEW LOOK
AT THE OLD DINOSAUR

Modern interpretations of life in the Mesozoic Era... were dinosaurs as metabolically advanced as mammals and birds or were they mere reptiles?

National Geographic Society
THE OCEAN REALM

Sweetlips and whales, lionfish and goosefish. Some starfish are cannibalistic and some algae taste like lettuce.

Pinna, Giovani
THE WORLD OF FOSSILS

The footprints of time are left impressed in a rock. Dragon flies, fish and frogs, fern and flowers captured through the centuries as fossils which provide us with immediate contact with a distant past.

Tazieff, Haroun (translated by Veronica Lawson)
THE MAKING OF THE EARTH

The Himalayas were caused by a collision between India and Asia...California might soon become an island in the Pacific Ocean.

White, John S. Jr.
COLOR UNDERGROUND

Take a look at the incredible variety of form and color to be found in the earth beneath our feet.

NUMBERS

Gower, Norman
AN INVITATION TO
MATHEMATICS

This is a book for people who are a little scared of math but would like to understand it a little better. It's not a book that's just about numbers, more about the way of thinking that lies behind mathematics.

Gudder, Stanley
A MATHEMATICAL JOURNEY

Try some puzzles, see how a computer works, find fascination in graphs. What probability resulted in the color of your eyes? The chapter on gambling covers chess, poker, and bridge.

Holt, Michael
MATH PUZZLES AND GAMES

For those who enjoy solving some of the world's more abstract problems.

Linn, Charles F.
PUZZLES, PATTERNS AND PASTIMES

From the world of mathematics comes puzzles like: "An hour ago 'twas as long after noon as 'twill be in another hour 'till midnight. The time now?" Puzzles as old as the Parthenon and as new as Skylab. Try 'em.

Ranucci, Ernest R.
Rollins, Wilma E.
CURIOSITIES OF THE CUBE

The mysteries and surprises to be found in cubes -- and you thought they were just square.

Schlossberg, Edwin
Brockman, John
THE POCKET CALCULATOR GAME BOOK (#1 and #2)

Games you can play on the simplest pocket calculator -- and you thought calculators were only good for math.

Snover, Stephen L.
Spikell, Mark A.
HOW TO PROGRAM YOUR PROGRAMMABLE CALCULATOR

More than 160 examples show you how to program your calculator to solve a variety of problems.

SPACE

Aylesworth, Thomas G.
WHO'S OUT THERE? THE SEARCH FOR EXTRATERRESTRIAL LIFE.

Have we been visited? Is someone sending messages? What Next?

Edelson, Edward
WHO GOES THERE? THE SEARCH FOR INTELLIGENT LIFE IN THE UNIVERSE

The sheer size of the universe seems to say that life on earth is not unique, and yet the search for extra-terrestrial intelligence is still a pioneer science.

Friedman, Herbert
THE AMAZING UNIVERSE

Over 200 photographs and illustrations bring exploding galaxies, the life cycle of stars, pulsars, quasars, and black holes down to earth.

Gallant, Roy A.
THE CONSTELLATIONS: HOW THEY CAME TO BE

Pisces, the fish, and Virgo, the virgin, -- how they came to be and their influences on various cultures throughout the world.

Kals, W. S.
HOW TO READ THE NIGHT SKY

"A new and easy way to know the stars, planets, and constellations."

Mitton, Jacqueline
Mitton, Simon
THE PRENTICE-HALL CONCISE BOOK OF ASTRONOMY

From the nearest and the farthest corners of the universe -- some of the latest space photographs.

Nicolson, Iain
THE ROAD TO THE STARS

Sometime, not too far into the future, we will travel among the stars helped on our way by current and foreseeable technologies. This is a book of fact and speculation about interstellar travel.

Sagan, Carl & others
MURMURS OF EARTH

In 1977, two Voyager spacecraft were launched from Earth never to return. Each carried affixed to their sides, a gold plated phonograph record -- a message from Earth to possible extraterrestial civilizations. Here is the story of that record, how and why it was created, and what it says.

BUILDING

Adkins, Jan
HOW A HOUSE HAPPENS

Building a house from the ground up.

Corbett, Scott
BRIDGES

The longest, the tallest, the most graceful, the greatest triumphs, the biggest disasters. Familiar bridges, strange bridges, old bridges, new bridges, and just plain "bridge" bridges.

Harmon, Margaret
MS. ENGINEER

Describes the field from automotive and aerospace engineering to petroleum engineering including a chapter on life roles and one on education.

Macaulay, David
CITY

Watch a city being built from the ground up by the ancient Romans, masters of the art of city planning.

Macaulay, David
PYRAMID

In 2470 BC, a new pharaoh of Egypt was crowned. Within 2 years, he began to plan the building of a tomb for himself that would last forever: a pyramid. This is how it was built.

Macaulay, David
UNDERGROUND

Have you any idea what goes on beneath the streets, sidewalks, and buildings of a city? Check it out.

Myller, Rolf
FROM IDEA INTO HOUSE

Even though buildings are different in size and shape, the story of how each is created usually follows the same fascinating pattern.

Salvadori, Mario
BUILDING

Why buildings and bridges stand up in the face of forces exerted on them by wind, earthquakes, and gravity. Good drawings, simple explanations, and experiments to help you understand.

Salvadori, Mario
WHY BUILDINGS STAND UP

Why buildings stand up and how engineers plan for every eventuality -- for all the forces that are exerted every day on a building. Why the Leaing Tower of Pisa doesn't fall over, how the Brooklyn Bridge was built, why the sports arena in Hartford collapsed.

THE WORLD OF CHEMISTRY AND PHYSICS

Beeler, Nelson F.
Branley, Franklyn M.
EXPERIMENTS IN OPTICAL ILLUSION

Remember -- seeing is not believing.

Chester, Michael
PARTICLES: AN INTRODUCTION TO PARTICLE PHYSICS

The world we live in is not as solid as it looks.

Dennis, Landt CATCH THE WIND	A book of windmills and windpower.
Gardner, Robert THIS IS THE WAY IT WORKS: A COLLECTION OF MACHINES	Here's how fluorescent lamps, projectors, lasers, microwave ovens, electric eyes, pace makers, artificial kidneys, scoreboards, solar heaters, nuclear reactors, and lots of other machines work.
Kettelkamp, Larry LASERS	The laser beam -- "the miracle light" -- how it works and what it can do.
Marten, Michael & others WORLDS WITHIN WORLDS	With electron micrography, kirlian and schlieren photography, holography, and other new photography techniques, you will see that the eye of an ant looks like an electrified raspberry, the tongue of a snail like the bark of a tree, a section of a nylon stocking like a cellophane fishing net, and that the past can be photographed from the present.
Medoff, Sol Powers, John THE STUDENT CHEMIST EXPLORES ATOMS AND MOLECULES	"See pictures in your mind" of the bonding and other actions of that almost unimaginable basis of all matter -- the atom.
Moche, Dinah RADIATION: BENEFITS/ DANGERS	Doctors, scientists, police, industries, and geologists all use radiation. Cosmic radiation comes from out in space. Every day we are exposed to some form of radiation, natural or man-made. Is it safe? Are the risks worth the benefits? These are hard questions.
Owen, Wilfred WHEELS	Imagine a world without the wheel.

Pauling, Linus
Hayward, Roger
THE ARCHITECTURE OF MOLECULES

One molecule looks like a beaded necklace, another like a glittering space station, some are round, some are square, some are very simple, some wonderfully complex -- all are beautiful in this book of illustrations of various molecules.

Pollard, Michael
HOW THINGS WORK

Helicopters and hovercraft, cars, and elevators, and telephones, and radios, and lasers, and oil rigs, and more.

Schwartz, Joe
EINSTEIN FOR BEGINNERS

A hip, cartoonish explanation of what the great man thought and discovered.

Trefil, James S.
PHYSICS AS A LIBERAL ART

To give you some idea of how a scientist learns to see the world so that when you come across some things scientific you'll have a better understanding of them.

Wohlrabe, Raymond A.
CRYSTALS

Transistors, snowflakes, the crystal "brains" of computers, geodes, as well as simple methods for growing crystals that are beautiful in form, pattern, and color.

BASIC SCIENCE COLLECTION

READINGS FROM SCIENTIFIC AMERICAN

LIFE SCIENCE LIBRARY

THE OCEAN WORLD OF JACQUES COUSTEAU

Three collections that will interest young women who never thought they would enjoy reading about science.